Behaviour of Flat Slab Rcc Structure Under Earthquake Loading

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***Abstract*—As flat slab building structures are significantly more flexible than traditional concrete frame/wall or frame structures, thus becoming more vulnerable to seismic loading. Therefore, the characteristics of the seismic behavior of flat slab buildings suggest that additional measures for guiding the conception and design of these structures in seismic regions are needed. To improve the performance of building having flat slabs under seismic loading, provision of flat slab with drop and without drop is proposed in the present work. The object of the present work is to compare the behaviour of multi-storey buildings having flat slabs with drops and without drop on the performance of these two types of buildings under seismic forces. And different types of zones and different type of soils condition as per IS code Provision Present work provides a good source of information on the parameters storey shear, base shear, storey drift, and maximum bending moment at column**

***Keywords*— Flat slab with drop and without drop, Storey drift, Storey shear, Base shear, Maximum bending moment.ETABS**

I. INTRODUCTION

Reinforced concrete has been used for building construction since the middle of the 19th century, first for some parts of buildings, and then for the entire building structure. Reinforced concrete is a major construction material for civil infrastructure in current society. Construction has always preceded the development of structural design methodology. Dramatic collapse of buildings has been observed after each disastrous earthquake, resulting in loss of life.

A flat slab is a reinforced concrete slab supported directly by concrete columns without the use of beams. Reinforced concrete flat slabs are one of the most popular floor systems used in residential buildings, car parks and many other structures. They represent elegant and easy-to-construct floor systems. Flat slabs are favored by both architects and clients because of their aesthetic appeal and economic advantage.

Reinforced concrete flat slabs are commonly used in construction as they provide a number of benefits to the designer including: 1.Thin sections allowing for greater roof heights and lighter floors, 2.Exposed ceilings, 3.Flexible column arrangements, this is more difficult to achieve for a beam-column design,4.Fast and cheap construction using simple formwork.

However, flat slabs have a lower stiffness in comparison to a beam-column floor plan which can lead to relatively large deflections. In addition to this, the shear capacity can also be reduced in particular around the column head where large shear forces can develop. There are two main failure modes of flat slabs: 1.Flexural Failure and 2.Punching Shear Failure.

Slabs are designed to fail by flexural failure, the failure mode is ductile therefore giving relatively large deflections under excessive loading, also cracks will appear on the bottom surface before failure occurs. These signs allow the problem to be addressed before failure occurs.

Punching shear failure by comparison is a brittle failure mode when shear reinforcement is not added, meaning failure will occur before significant deflections take place, in addition to this any cracks that will develop before failure will propagate from the top surface. Since this surface is typically covered, it is unlikely that there will be sufficient warning available before failure occurs.

II. PROBLEM FORMULATION

In our study we are focusing on the behaviour of flat slab rcc structure of two different types one is with drops and another one is without drop which involves its behaviour for earthquake condition. As it is clear from previous literature that flat slab structure are unstable for seismic forces, we are analytically investigating the effect of flat slab generally with various site condition and in various earthquake zones. The analysis method considering for the Response spectrum method as per IS provision. And by using ETABS software also

III. PARAMETERS CONSIDERED

The parameters considered in the performance evaluation are as under

1. Flat Slab Framed Structures subjected to seismic forces.
2. Flat Slab Framed Structures subjected to different zones and different soil condition as per IS 1893 (Part-1): 2002

3. Analysis method Equivalent static analysis (ESA) and Response spectrum analysis (RSA).
4. Maximum Bending moment and Storey Drift in the buildings with and without Drop.
5. Storey Shear and Design base shear in the buildings with and without Drop.

IV.MODELING AND ANALYSIS

Description of building:

Type of structure: Multi-storey Flat slab RCC structure with and without Drops

Occupancy: Office Building
Number of stories: 6(G+5)
Ground storey height: 3.5m
Intermediate storey height: 3.5m
Model design: One of the objectives of this model designing is to ensure that the models represent the characteristics of commercial buildings. These days, high-rise buildings are different in shape, height and functions. This makes each building characteristics different from each others. There are some standards for each kind of high-rise buildings, such as residential, official and commercials. However, for model designing, main factors such as grid spacing, floor shape, floor height and column section were considered. Two buildings with equal number of stories, with 6(G+5) story having same floor plan of 77 m × 55m dimensions were considered for this study. The floor plans were divided into seven by five bays in such a way that center to center distance between two grids is 11 meters and 11 meters respectively.
Model 1: Building having flat slab without drops
Model 2: Building having flat slab with drops
The modeling of the structure has been done using the structural software ETABS as
per the data given below:

Design Parameters

Type of soil: Soil type 1 (Hard soil) and Soil type 2 (Medium soil)
Zones: Zone-2 and Zone-3 and Zone-4

Materials

Grade of Concrete: M25
Density of Concrete: 25kN/m2
Modulus of Elasticity of concrete: 5000√fck (As per IS 456:2000[11], pp16)

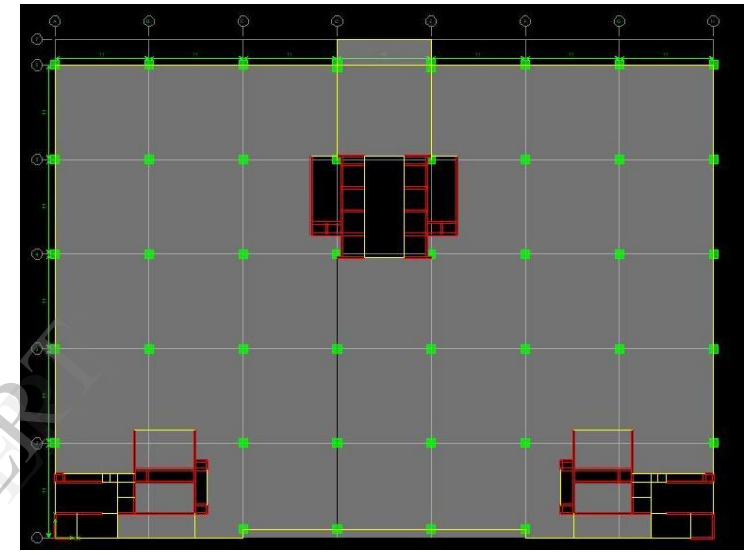
Member dimensions

CornerBeamSizes:BM300X900mm,BM1000X750mm,BM1500X900mm,BM200X900mm,BM350X1000mm,BM200X1000mm,BM300X750mm,BM200X750mm,BM350X750mm,BM1000X900mm,BM600X900mm
Column Sizes: 1000X1000mm and 1000X1500mm
Slab Thickness: 275mm
Wall Thickness: 250mm
Shear Wall Thickness: 250mm
Drop Thickness: 500mm

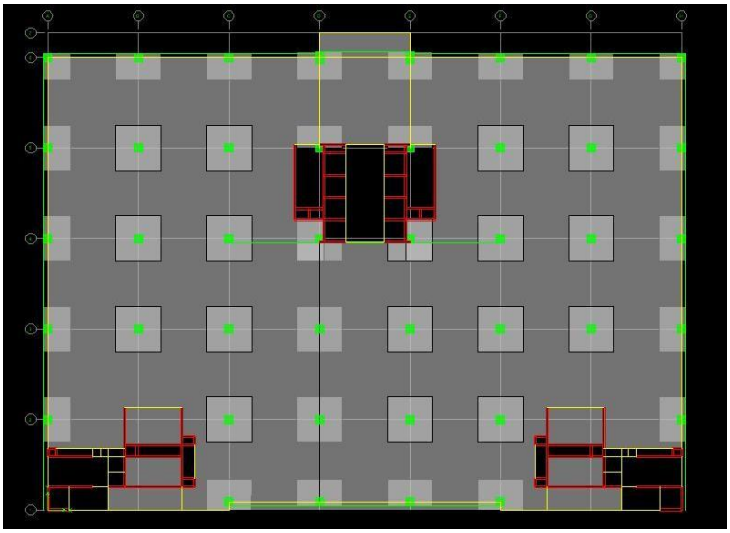
Method of dynamic analysis:

Building with regular or nominally irregular plan configuration may be modeled as a system of masses lumped at floor levels with each mass having one degree of freedom, that of lateral displacement in the direction under consideration. Undamped free vibration analysis of entire building modeled as spring – mass model shall be performed using appropriate masses and elastic stiffness of the structural system to obtain natural periods (T) and mode shapes {f} of those of its modes of vibration that needs to be considered. The number of modes to be used should be such that the sum of total of modal masses of all modes considered is at least 90% of total seismic mass

Plan for Flat slab without drop and with drop



Plan of flat slab without drop



Plan of flat slab with drop

Dynamic analysis

1. Response spectrum method is used for analysis, Importance factor & response reduction factor are considered as 1 & 5

respectively. By considering 12 modes mass participation of flat slab building is achieved up to 96%(following table)
2. Therefore for all buildings 12 modes are considered.
3. Ritz Vector analyses are used for analysis. Rigid diaphragm action is considered for analysis.

Center of mass & centre of rigidity coincides, due to regularity in the plan, mass and stiffness of the building.

Details of time period and mass participation for flat slab without drop building

Mode	Time Period	% mass participation	Cumulative Mass participation
1	0.44001	35.8179	35.8179
2	0.315	0	35.8179
3	0.25786	39.6196	75.4376
4	0.1222	8.0967	83.5343
5	0.08876	0.0001	83.5344
6	0.07349	7.8684	91.4028
7	0.06484	0	91.4028
8	0.06474	0.0022	91.405
9	0.06272	2.3058	93.7107
10	0.06265	0.0033	93.714
11	0.06228	0.2934	94.0074
12	0.05939	0	94.0074

Details of time period and mass participation for flat slab with drop building

Mode	Time Period	% mass participation	Cumulative Mass participation
1	0.462062	37.0061	37.0061
2	0.335397	0.0018	37.0079
3	0.27648	38.92	75.9279
4	0.131079	7.9922	83.9201
5	0.095838	0.0001	83.9202
6	0.079527	7.7426	91.6628
7	0.067701	2.779	94.4419
8	0.064879	0	94.4419
9	0.064798	0.012	94.4539
10	0.062733	0	94.4539
11	0.062593	0.0161	94.47
12	0.059419	0	94.47

V.RESULTS:

Results for flat slab without drop building.

Table 5.1 Design Storey shear for Flat slab without drop building in zone-2 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	STOREY SHEAR (KN)	
		ZONE II SOIL TYPE-1 (HARD SOIL)	ZONE II SOIL TYPE-2 (MEDIUM SOIL)
3.5	STOREY 1	3492.65	3594.07
7	STOREY 2	3348.43	3448.06
10.5	STOREY 3	3020.31	3112.73
14	STOREY 4	2527.85	2605.28
17.5	STOREY 5	1854.99	1909.95
21	STOREY 6	962.46	989.55

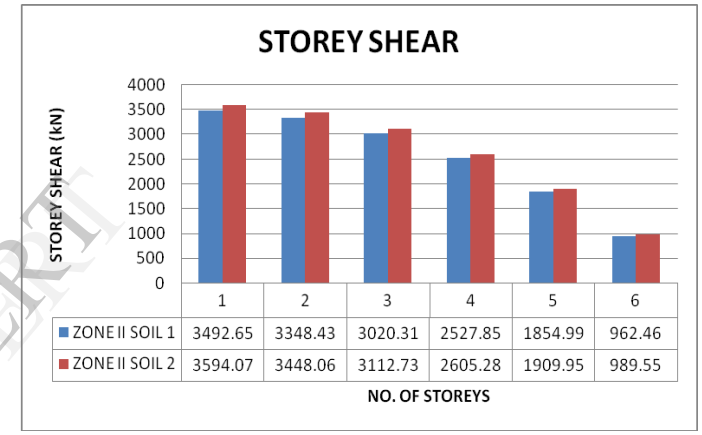


Figure5.1 Design Storey Shear for flat slab without drop building in zone-2, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 5.2 Storey Drift for Flat slab without drop building in zone-2 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	DRIFT-X ZONE II SOIL TYPE1 (HARD SOIL)	DRIFT-X ZONE II SOIL TYPE2 (MEDIUM SOIL)	UNITS
3.5	STOREY 1	0.042	0.045	MM
7	STOREY 2	0.08	0.086	MM
10.5	STOREY 3	0.094	0.1	MM
14	STOREY 4	**0.096**	**0.103**	MM
17.5	STOREY 5	0.091	0.097	MM
21	STOREY 6	0.079	0.085	MM

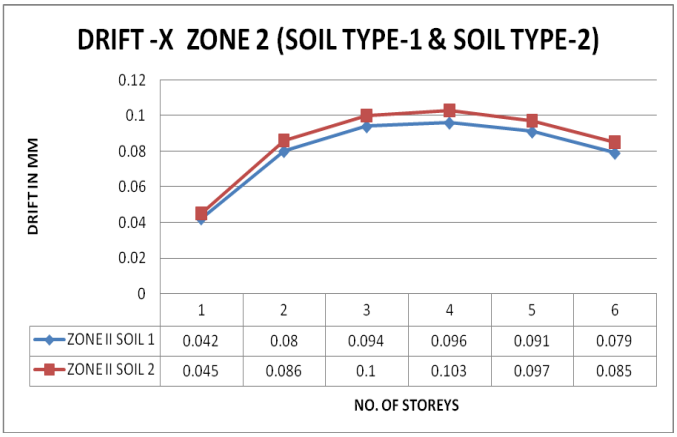


Figure5.2 Storey Drift in X-direction for flat slab without drop building in zone-2, soil type-1 and soil type-2 (Hard Soil and Medium soil).

Table 5.3 Maximum bending moment at Column No.45 in Storey No.4 for Flat slab without drop building in zone-2, soil type-1 (Hard soil)

SOIL TYPE 1 (ZONE 2)					
Story	**Column**	**Load**	**Loc**	**P**	**BM**
STORY4	C45	SPEC1	0	121.08	**200.655 KN-M**
STORY4	C45	SPEC1	1.3	121.08	**51.922 KN-M**
STORY4	C45	SPEC1	2.6	121.08	**96.943 KN-M**
STORY4	C45	SPEC2	0	47.87	**29.1 KN-M**
STORY4	C45	SPEC2	1.3	47.87	**7.514 KN-M**
STORY4	C45	SPEC2	2.6	47.87	**14.073 KN-M**

Table 5.4 Maximum bending moment at Column No.45 in Storey No.4 for Flat slab without drop building in zone-2, soil type-2 (Medium soil)

SOIL TYPE 2 (ZONE 2)					
Story	**Column**	**Load**	**Loc**	**P**	**BM**
STORY4	C45	SPEC1	0	129.17	**214.246 KN-M**
STORY4	C45	SPEC1	1.3	129.17	**55.418 KN-M**
STORY4	C45	SPEC1	2.6	129.17	**103.533 KN-M**
STORY4	C45	SPEC2	0	47.86	**29.151 KN-M**
STORY4	C45	SPEC2	1.3	47.86	**7.527 KN-M**
STORY4	C45	SPEC2	2.6	47.86	**14.099 KN-M**

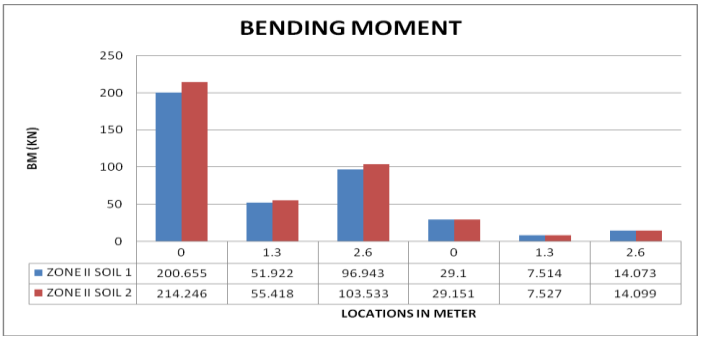


Figure5.3 and 5.4 Maximum bending moment at Column No.45 in Storey No.4 for flat slab without drop building in zone-2, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 5.5 Design Storey shear for Flat slab without drop building in zone-3 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	STOREY SHEAR (KN)	
		ZONE III SOIL TYPE-1 (HARD SOIL)	ZONE III SOIL TYPE-2 (MEDIUM SOIL)
3.5	STOREY 1	5588.24	5750.51
7	STOREY 2	5357.48	5516.89
10.5	STOREY 3	4832.5	4980.36
14	STOREY 4	4044.57	4168.45
17.5	STOREY 5	2967.99	3055.91
21	STOREY 6	1539.94	1583.28

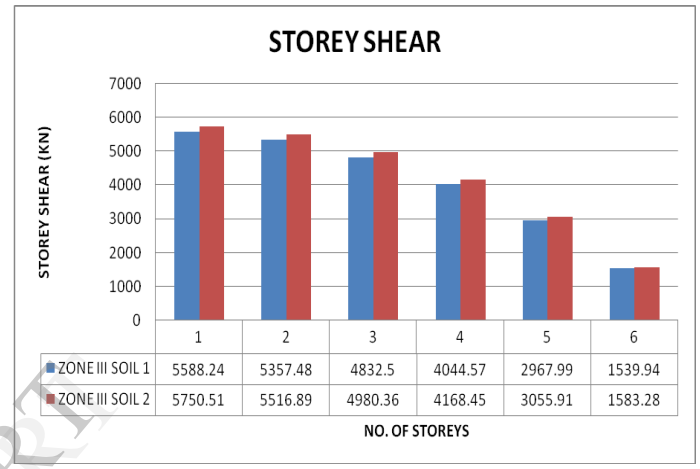


Figure5.5 Design Storey Shear for flat slab without drop building in zone-3, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 5.6 Storey Drift for Flat slab without drop building in zone-3 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	DRIFT-X ZONE III SOIL TYPE1 (HARD SOIL)	DRIFT-X ZONE III SOIL TYPE2 (MEDIUM SOIL)	UNITS
3.5	STOREY 1	0.068	0.072	MM
7	STOREY 2	0.129	0.137	MM
10.5	STOREY 3	0.15	0.16	MM
14	STOREY 4	**0.154**	**0.164**	MM
17.5	STOREY 5	0.145	0.155	MM
21	STOREY 6	0.127	0.136	MM

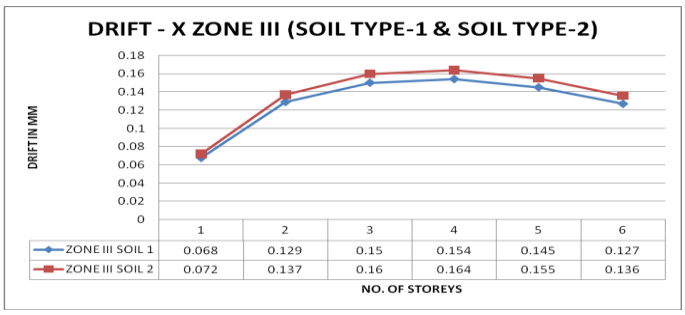


Figure5.6 Storey Drift in X-direction for flat slab without drop building in zone-3, soil type-1 and soil type-2 (Hard Soil and Medium soil).

Table 5.7 Maximum bending moment at Column No.45 in Storey No.4 for Flat slab without drop building in zone-3, soil type-1 (Hard soil)

SOIL TYPE 1 (ZONE 3)					
Story	Column	Load	Loc	P	BM
STORY4	C45	SPEC1	0	193.72	321.048 KN-M
STORY4	C45	SPEC1	1.3	193.72	83.076 KN-M
STORY4	C45	SPEC1	2.6	193.72	155.109 KN-M
STORY4	C45	SPEC2	0	76.59	46.56 KN-M
STORY4	C45	SPEC2	1.3	76.59	12.023 KN-M
STORY4	C45	SPEC2	2.6	76.59	22.517 KN-M

Table 5.8 Maximum bending moment at Column No.45 in Storey No.4 for Flat slab without drop building in zone-3, soil type-2 (Medium soil)

SOIL TYPE 2 (ZONE 3)					
Story	Column	Load	Loc	P	BM
STORY4	C45	SPEC1	0	206.68	342.794 KN-M
STORY4	C45	SPEC1	1.3	206.68	88.669 KN-M
STORY4	C45	SPEC1	2.6	206.68	165.653 KN-M
STORY4	C45	SPEC2	0	76.58	46.642 KN-M
STORY4	C45	SPEC2	1.3	76.58	12.043 KN-M
STORY4	C45	SPEC2	2.6	76.58	22.559 KN-M

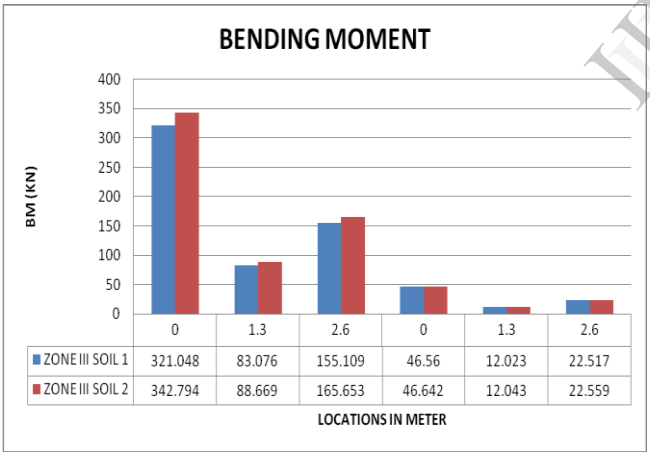


Figure5.7 and 5.8 Maximum bending moment at Column No.45 in Storey No.4 for flat slab without drop building in zone-3, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 5.9 Design Storey shear for Flat slab without drop building in zone-4 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	STOREY SHEAR (KN)	
		ZONE IV SOIL TYPE-1 (HARD SOIL)	ZONE IV SOIL TYPE-2 (MEDIUM SOIL)
3.5	STOREY 1	8382.36	8625.77
7	STOREY 2	8036.23	8275.34
10.5	STOREY 3	7248.75	7470.54
14	STOREY 4	6066.85	6252.67
17.5	STOREY 5	4451.98	4583.87
21	STOREY 6	2309.9	2374.91

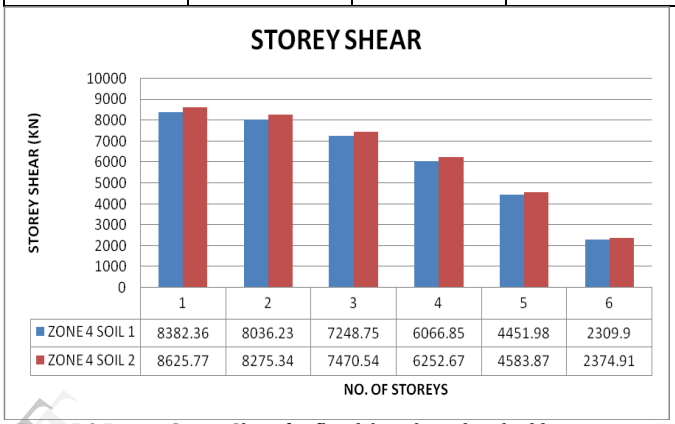


Figure5.9 Design Storey Shear for flat slab without drop building in zone-4, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 6.0 Storey Drift for Flat slab without drop building in zone-4 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	DRIFT-X ZONE IV SOIL TYPE1 (HARD SOIL)	DRIFT-X ZONE IV SOIL TYPE2 (MEDIUM SOIL)	UNITS
3.5	STOREY 1	0.102	0.109	MM
7	STOREY 2	0.193	0.206	MM
10.5	STOREY 3	0.224	0.24	MM
14	STOREY 4	0.231	0.246	MM
17.5	STOREY 5	0.218	0.232	MM
21	STOREY 6	0.191	0.203	MM

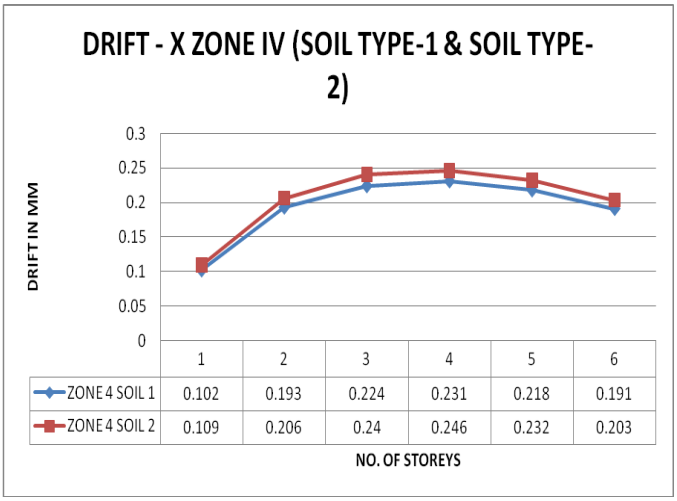


Figure6.0 Storey Drift in X-direction for flat slab without drop building in zone-4, soil type-1 and soil type-2 (Hard Soil and Medium soil).

Table 7.1 Maximum bending moment at Column No.45 in Storey No.4 for Flat slab without drop building in zone-4, soil type-1 (Hard soil)

SOIL TYPE 1 (ZONE 4)					
Story	**Column**	**Load**	**Loc**	**P**	**BM**
STORY4	C45	SPEC1	0	290.59	**481.572 KN-M**
STORY4	C45	SPEC1	1.3	290.59	**124.614 KN-M**
STORY4	C45	SPEC1	2.6	290.59	**232.663 KN-M**
STORY4	C45	SPEC2	0	114.88	**69.839 KN-M**
STORY4	C45	SPEC2	1.3	114.88	**18.034 KN-M**
STORY4	C45	SPEC2	2.6	114.88	**33.776 KN-M**

Table 7.2 Maximum bending moment at Column No.45 in Storey No.4 for Flat slab without drop building in zone-4, soil type-2 (Medium soil)

SOIL TYPE 2 (ZONE 4)					
Story	Column	Load	Loc	P	BM
STORY4	C45	SPEC1	0	310.02	514.191 KN-M
STORY4	C45	SPEC1	1.3	310.02	133.004 KN-M
STORY4	C45	SPEC1	2.6	310.02	248.48 KN-M
STORY4	C45	SPEC2	0	114.87	69.963 KN-M
STORY4	C45	SPEC2	1.3	114.87	18.065 KN-M
STORY4	C45	SPEC2	2.6	114.87	33.838 KN-M

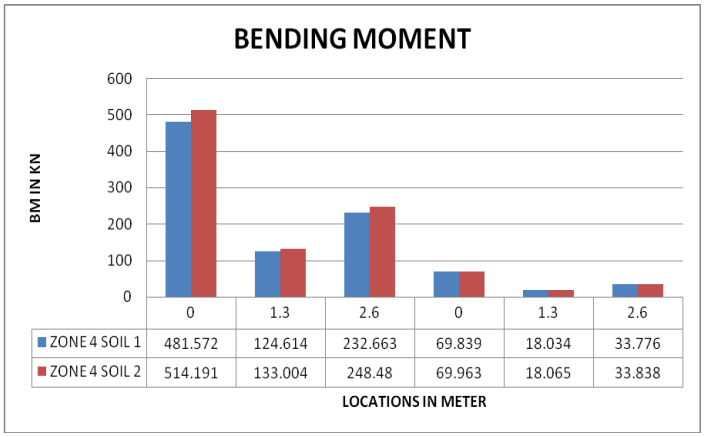


Figure7.1 and 7.2 Maximum bending moment at Column No.45 in Storey No.4 for flat slab without drop building in zone-4, soil type-1 and soil type-2 (Hard soil and Medium soil).

Results for flat slab with drop building

Table 7.3 Design Storey shear for Flat slab with drop building in zone-2 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	STOREY SHEAR (KN)	
		ZONE II SOIL TYPE-1 (HARD SOIL)	ZONE II SOIL TYPE-2 (MEDIUM SOIL)
3.5	STOREY 1	4194.49	4395.29
7	STOREY 2	4015.16	4212.23
10.5	STOREY 3	3618.29	3800.59
14	STOREY 4	3029.52	3181.71
17.5	STOREY 5	2228.59	2336.32
21	STOREY 6	1169.28	1222.53

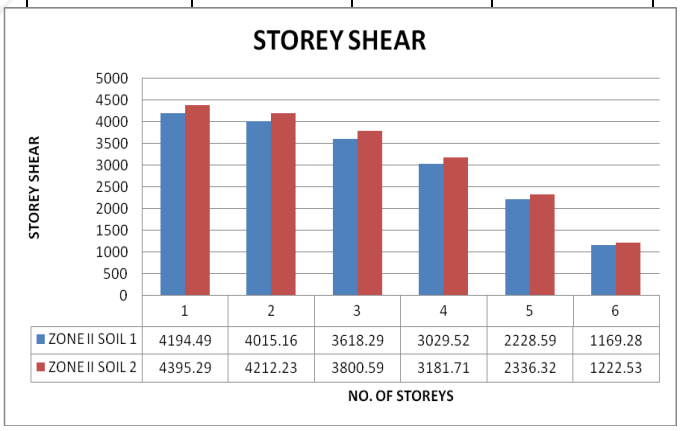


Figure7.3 Design Storey Shear for flat slab with drop building in zone-2, soil type-1 and soil type-2 (Hard soil and Medium soil)

Table 7.4 Storey Drift for Flat slab with drop building in zone-2 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	DRIFT-X ZONE II SOIL TYPE1 (HARD SOIL)	DRIFT-X ZONE II SOIL TYPE2 (MEDIUM SOIL)	UNITS
3.5	STOREY 1	0.048	0.053	MM
7	STOREY 2	0.088	0.097	MM
10.5	STOREY 3	0.1	0.111	MM
14	STOREY 4	0.101	0.112	MM
17.5	STOREY 5	0.094	0.104	MM
21	STOREY 6	0.08	0.089	MM

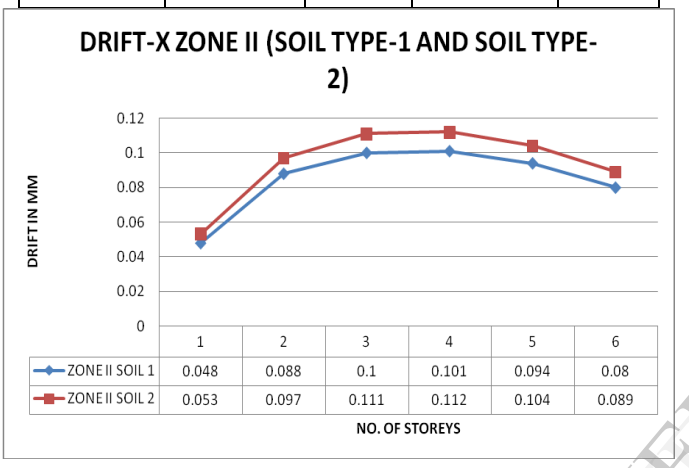


Figure7.4 Storey Drift in X-direction for flat slab with drop building in zone-2, soil type-1 and soil type-2 (Hard Soil and Medium soil).

Table 7.5 Maximum bending moment at Column No.44 in Storey No.4 for Flat slab with drop building in zone-2, soil type-1 (Hard soil)

SOIL TYPE 1 (ZONE 2)					
Story	Column	Load	Loc	P	BM
STORY4	C44	SPEC1	0	117.14	222.754 KN-M
STORY4	C44	SPEC1	1.3	117.14	57.231 KN-M
STORY4	C44	SPEC1	2.6	117.14	108.431 KN-M
STORY4	C44	SPEC2	0	63.8	32.676 KN-M
STORY4	C44	SPEC2	1.3	63.8	8.387 KN-M
STORY4	C44	SPEC2	2.6	63.8	15.903 KN-M

Table 7.6 Maximum bending moment at Column No.44 in Storey No.4 for Flat slab with drop building in zone-2, soil type-2 (Medium soil)

SOIL TYPE 2 (ZONE 2)					
Story	Column	Load	Loc	P	BM
STORY4	C44	SPEC1	0	129.72	247.089 KN-M
STORY4	C44	SPEC1	1.3	129.72	63.446 KN-M
STORY4	C44	SPEC1	2.6	129.72	120.322 KN-M
STORY4	C44	SPEC2	0	63.8	32.676 KN-M
STORY4	C44	SPEC2	1.3	63.8	8.388 KN-M
STORY4	C44	SPEC2	2.6	63.8	15.903 KN-M

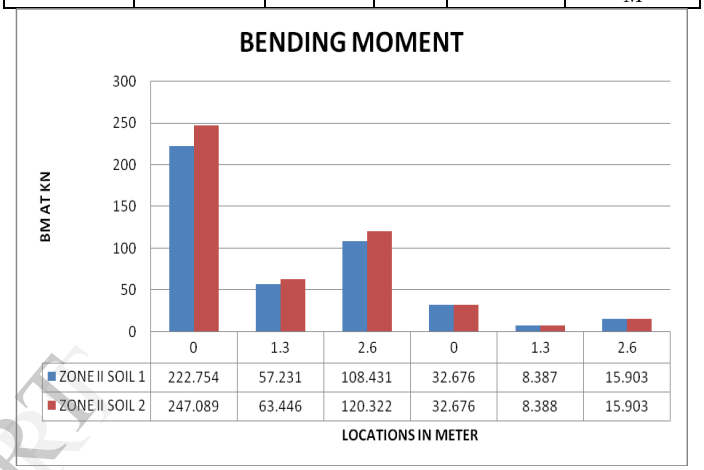


Figure7.5 and 7.6 Maximum bending moment at Column No.44 in Storey No.4 for flat slab with drop building in zone-2, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 7.7 Design Storey shear for Flat slab with drop building in zone-3 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	STOREY SHEAR (KN)	
		ZONE III SOIL TYPE1 (HARD SOIL)	ZONE III SOIL TYPE2 (MEDIUM SOIL)
3.5	STOREY 1	6711.19	7032.47
7	STOREY 2	6424.26	6739.57
10.5	STOREY 3	5789.26	6080.95
14	STOREY 4	4847.23	5090.74
17.5	STOREY 5	3565.74	3738.11
21	STOREY 6	1870.85	1956.06

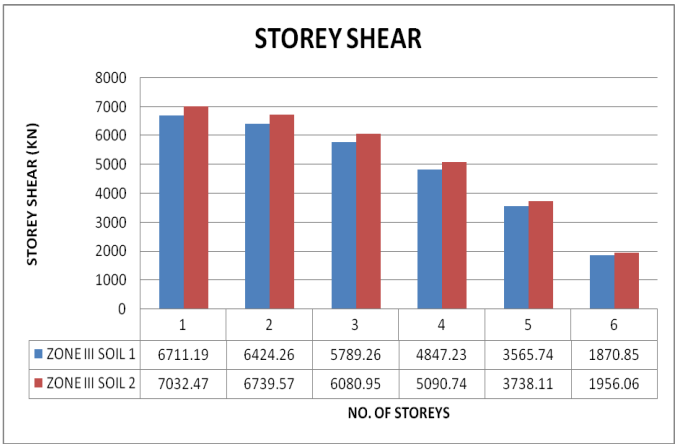


Figure7.7 Design Storey Shear for flat slab with drop building in zone-3, soil type-1 and soil type-2 (Hard soil and Medium soil)

Table 7.8 Storey Drift for Flat slab with drop building in zone-3 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	DRIFT-X ZONE III SOIL TYPE1 (HARD SOIL)	DRIFT-X ZONE III SOIL TYPE2 (MEDIUM SOIL)	UNITS
3.5	STOREY 1	0.076	0.085	MM
7	STOREY 2	0.14	0.155	MM
10.5	STOREY 3	0.16	0.178	MM
14	STOREY 4	0.162	0.18	MM
17.5	STOREY 5	0.15	0.167	MM
21	STOREY 6	0.128	0.142	MM

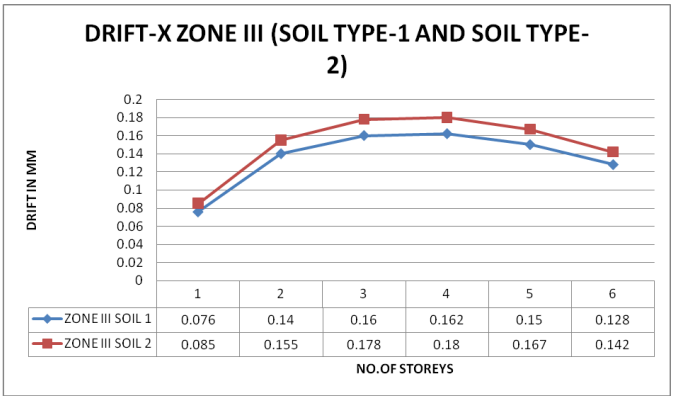


Figure7.8 Storey Drift in X-direction for flat slab with drop building in zone-3, soil type-1 and soil type-2 (Hard Soil and Medium soil).

Table 7.9 Maximum bending moment at Column No.44 in Storey No.4 for Flat slab with drop building in zone-3, soil type-1 (Hard soil)

SOIL TYPE 1 (ZONE 3)					
Story	**Column**	**Load**	**Loc**	**P**	**BM**
STORY4	C44	SPEC1	0	187.42	**356.407 KN-M**
STORY4	C44	SPEC1	1.3	187.42	**91.57 KN-M**
STORY4	C44	SPEC1	2.6	187.42	**173.489 KN-M**
STORY4	C44	SPEC2	0	102.08	**52.281 KN-M**
STORY4	C44	SPEC2	1.3	102.08	**13.42 KN-M**
STORY4	C44	SPEC2	2.6	102.08	**25.445 KN-M**

Table 8.0 Maximum bending moment at Column No.44 in Storey No.4 for Flat slab with drop building in zone-3, soil type-2 (Medium soil)

SOIL TYPE 2 (ZONE 3)					
Story	Column	Load	Loc	P	BM
STORY4	C44	SPEC1	0	207.56	395.343 KN-M
STORY4	C44	SPEC1	1.3	207.56	101.513 KN-M
STORY4	C44	SPEC1	2.6	207.56	192.516 KN-M
STORY4	C44	SPEC2	0	102.08	52.282 KN-M
STORY4	C44	SPEC2	1.3	102.08	13.42 KN-M
STORY4	C44	SPEC2	2.6	102.08	25.445 KN-M

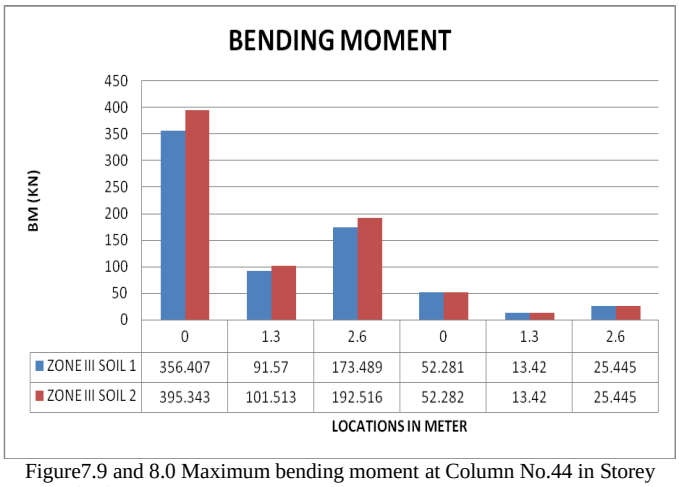


Figure7.9 and 8.0 Maximum bending moment at Column No.44 in Storey No.4 for flat slab with drop building in zone-3, soil type-1 and soil type-2 (Hard soil and Medium soil).

Table 8.1 Design Storey shear for Flat slab with drop building in zone-4 different type of soils

HEIGHT OF	STOREY NO.	STOREY SHEAR (KN)

BUILDING (Mt.)		ZONE IV SOIL TYPE-1 (HARD SOIL)	ZONE IV SOIL TYPE-2 (MEDIUM SOIL)
3.5	STOREY 1	10066.79	10548.7
7	STOREY 2	9636.39	10109.36
10.5	STOREY 3	8683.88	9121.42
14	STOREY 4	7270.84	7636.12
17.5	STOREY 5	5348.62	5607.16
21	STOREY 6	2806.28	2934.08

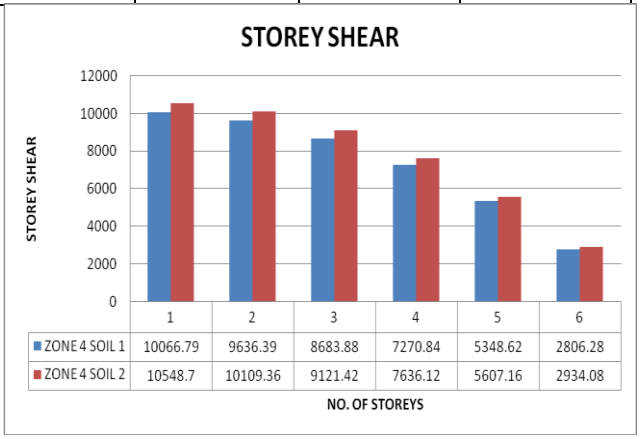


Figure8.1 Design Storey Shear for flat slab with drop building in zone-4, soil type-1 and soil type-2 (Hard soil and Medium soil)

Table 8.2 Storey Drift for Flat slab with drop building in zone-4 different type of soils

HEIGHT OF BUILDING (Mt.)	STOREY NO.	DRIFT-X ZONE IV SOIL TYPE1 (HARD SOIL)	DRIFT-X ZONE III SOIL TYPE2 (MEDIUM SOIL)	UNITS
3.5	STOREY 1	0.115	0.127	MM
7	STOREY 2	0.21	0.233	MM
10.5	STOREY 3	0.24	0.266	MM
14	STOREY 4	0.243	0.27	MM
17.5	STOREY 5	0.226	0.25	MM
21	STOREY 6	0.192	0.213	MM

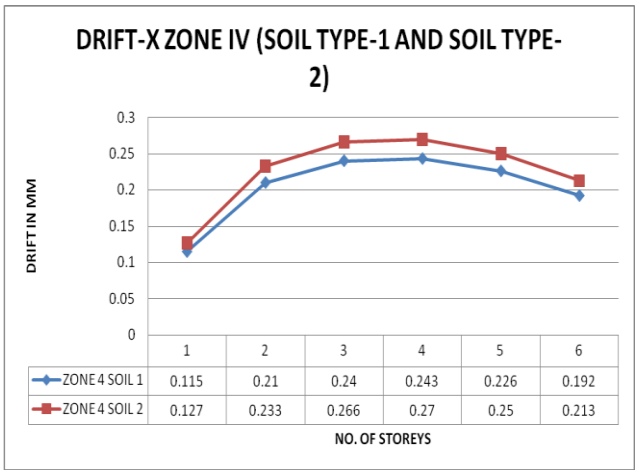


Figure8.2 Storey Drift in X-direction for flat slab with drop building in zone-4, soil type-1 and soil type-2 (Hard Soil and Medium soil).

Table 8.3 Maximum bending moment at Column No.44 in Storey No.4 for Flat slab with drop building in zone-4, soil type-1 (Hard soil)

SOIL TYPE 1 (ZONE 4)					
Story	Column	Load	Loc	P	BM
STORY4	C44	SPEC1	0	281.13	534.61 KN-M
STORY4	C44	SPEC1	1.3	281.13	137.354 KN-M
STORY4	C44	SPEC1	2.6	281.13	260.234 KN-M
STORY4	C44	SPEC2	0	153.12	78.422 KN-M
STORY4	C44	SPEC2	1.3	153.12	20.13 KN-M
STORY4	C44	SPEC2	2.6	153.12	38.167 KN-M

Table 8.4 Maximum bending moment at Column No.44 in Storey No.4 for Flat slab with drop building in zone-4, soil type-2 (Medium soil)

SOIL TYPE 2 (ZONE 4)					
Story	Column	Load	Loc	P	BM
STORY4	C44	SPEC1	0	311.34	593.014 KN-M
STORY4	C44	SPEC1	1.3	311.34	152.27 KN-M
STORY4	C44	SPEC1	2.6	311.34	288.774 KN-M
STORY4	C44	SPEC2	0	153.12	78.424 KN-M
STORY4	C44	SPEC2	1.3	153.12	20.13 KN-M
STORY4	C44	SPEC2	2.6	153.12	38.168 KN-M

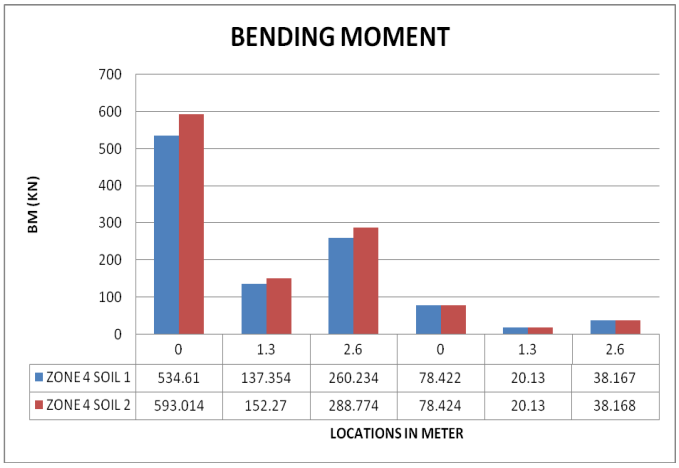


Figure8.3 and 8.4 Maximum bending moment at Column No.44 in Storey No.4 for flat slab with drop building in zone-4, soil type-1 and soil type-2 (Hard soil and Medium soil).

CONCLUSIONS:

Within the scope of present work following conclusions are drown

1. For all the cases considered drift values follow a parabolic path along storey height with maximum value laying the fourth storey.
2. Use of flat slab with drop and without drop results in drift value is marginally in a range of 0.5mm to 3mm. still all drift values are within permissible limits, even with shear walls.
3. The fundamental natural period value is much higher in flat slab with drop buildings compared to flat slab without drop building.
4. For all the structure, design base shear increases as the number of stories increases. This increases design base shear is gradual up to 6^{th} storey. The design base shear of soil type-1 is less than the soil type-2 for all type of zones.
5. The design base shear of zone-4 is higher compare to other zones (i.e., zone-3 and zone-2) for all type of structures.

6. In flat slab without drop building the maximum bending moment at column no.45 in storey no.4 for all type of soils and zone. In such that the flat slab with drop building the maximum bending moment at column no.44 in storey no.4 for all type of soils and zones.

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